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ABSTRACT

Unintentional movement "overflow" between the hands or "mirror movements" are common in young children, but are generally regarded as indicative of developmental delay in older children. This study was designed to investigate mirror movements in a sample of 23 very poor readers, ages 11-13, with learning disabilities, and in a control group of 48 normal readers, matched for age, sex, and handedness. Five rapid repetitive movements and eight slow finger-displacement movements were studied, and overflow to the opposite hand was quantified. A significant interaction of reading ability with type of movement was observed, with reading-impaired children making more mirror movements during slow finger displacements (but not during rapid repetitive movements) than normal readers. Reading-impaired children showed greater left-hand overflow and normal control children showed greater right-hand overflow overall. The two groups were differentiated by the pattern of overflow rather than the overall amount. It is concluded that dyslexic children were more likely than normal children to co-activate the left hemisphere whenever the left hand was used, and dyslexic children activated both hemispheres in circumstances where normal children did not. (Includes seven references.) (JDD)

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A Closer Look at Motor Overflow in Dyslexic Children*

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ABSTRACT

The effects of type of movement and reading ability on "mirror movements" were examined in ?? carefully selected poor-readers between 11 and 13 years of age, and in a control sample of 48 normal-readers, matched for age, sex and handedness. These poor-readers had very poor word-recognition skills (Wrat-R reading, M=3 %ile) despite normal intelligence and adequate educational opportunities. A significant interaction of **reading ability x type of movement** was observed, with reading-impaired children making more mirror movements during slow finger-displacements (but not during rapid repetitive movements) than normal-readers. The interaction of **reading ability x hand** was also significant. Reading-impaired children showed greater left-hand overflow and normal control children greater right-hand overflow overall. Implications for brain organization in dyslexia are discussed.

Introduction

Unintentional movement "overflow" between the hands or "mirror movements" are common in young children. The frequency and magnitude of overflow decreases sharply over the first decade, however, and mirror movement in older children is generally regarded as a soft neurological sign indicating developmental delay. Although the concept of soft signs has been severely criticized by some researchers (eg. Rutter, 1982), Spreen (1989) observed that the presence of hard and soft signs were predictive of poor adult outcome in a large sample of learning-disabled (LD) children. He noted that there is a "need for a closer inspection of the presence of soft and hard neurological signs in ld children" (p. 404).

Mirror movements can be elicited in older children and adults fairly easily in the laboratory. Typically, it is reported that mirror movements are more frequent when the left hand performs the intended movement than when the right hand does so (eg. Liederman & Foley, 1987). Parlow (1990, see also Parlow & Aubin, 1991) has argued that this is not always the case, and that hand differences in contralateral overflow depend on handedness and also on task characteristics. She showed that right-handed children between 7 and 12 years of age produced greater left-hand overflow during rapid repetitive (left hemisphere) movements but greater right-hand overflow during slow (right hemisphere) finger-displacements. Parlow has proposed that mirror movements are more likely to occur when the "wrong" hand is used, as activation of the nonspecialized hemisphere may result in the recruitment or coactivation of the specialized hemisphere (see also Parlow & Kinsbourne, 1989).

The present study was designed to investigate mirror movements in a sample of very poor readers. The effects of hand

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used and type of movement were examined as well as reading

ability.

Procedure

Five rapid repetitive movements (including forearm pronation/supination, one-finger tapping, and finger-thumb alternation tasks) and eight slow finger-displacement movements (finger-lifting and finger-spreading movements) were studied. Overflow to the opposite hand was quantified using a 3-point scale, with 0=no movement, 1=non-specific movement, 2=specific mirror movement (such that homologous muscles moved substantially in synchrony with the intended movement). Composite scores were used for the analysis, based on the sum of the rapid repetitive tasks (divided by 5) and the sum of the slow finger-displacement tasks (divided by 8).

Analysis

Overflow scores were entered into a 2 (reading ability) x 2 (hand) x 2 (type of movement) ANCOVA. Hand and type of movement were repeated measures. Four covariates were included in the analysis: sex, age (in months), left hand preference score (out of 15 unimanual tasks) and a familial sinistrality score (indicating the absence or presence of left-handers among first and second degree relatives).

Subjects

POOR READERS (N=23):

Most of the poor-readers were identified from a search of records at a large hospital for children; the remainder (6) were referred through the special education program in a local school board. The following criteria were used to select poor readers:

* aged between 11 and 13 years
* diagnosis of LD with significant reading problems, defined as reading at least 2 years behind age expectations and with scores at or below the 25th %ile on one or more individually administered standardized reading tests
* normal intelligence (WISC-R: VIQ, PIQ or FIQ >90)
* first language is English with English spoken at home and at school
* no history of significant social, emotional, behavioural, attentional, neurological or other problems.

Children meeting these criterion were then given the reading subtest from the wide range achievement test-revised (WRAT-R); children with reading scores above the 25th percentile on this test were excluded from the study. This procedure produced a relatively homogeneous sample of children, all of whom had severe reading problems at the word-recognition level (WRAT-R score, *M*= 3%ile).

CONTROL READERS (n=48):

A total of 62 children in grade 6 at three local schools were tested and considered for inclusion in the control group. Fourteen were subsequently excluded for a variety of reasons (epilepsy, emotional problems, special education status, first language other than English). Although reading ability was not used as a basis for exclusion in the control sample, all children in the final sample achieved scores on the WRAT-R reading test above the 25th percentile (*M*= 79%ile). Comparison with poor readers revealed the two samples to be well-matched with respect

to age, sex and handedness.

Results

The analysis yielded two interactions: reading ability x type of movement, $F(1, 67) = 8.82$, $p<.01$; And reading ability x hand, $F(1, 67) = 6.11$, $p<.05$. These are described below:

1. Contrary to expectation, the poor readers did not make more mirror movements during rapid repetitive tasks than the control group. However, they did make more mirror movements during slow finger-displacements.
2. Greater left hand overflow was found among the poor readers but not among the control group children. The latter showed greater right hand overflow overall.

Conclusions

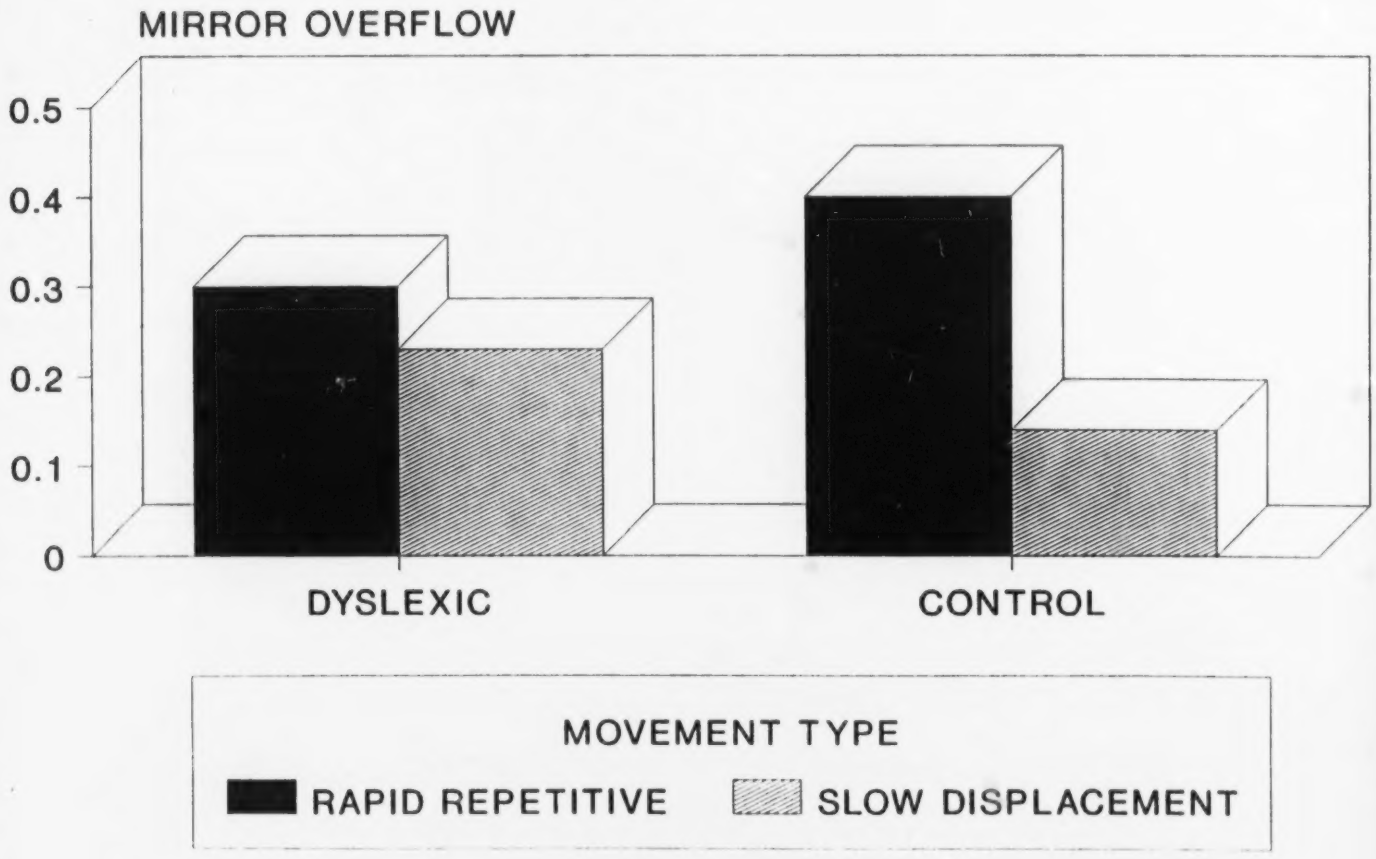
1. Although it is generally accepted by clinicians that LD children will display more mirror overflow during intended actions than control children, this belief was not supported in the present study. The two groups were differentiated by the pattern of overflow rather than the overall amount. While controls produced more mirror overflow during rapid repetitive movements than during slow displacement movements, dyslexic children produced mirror movements equally often for both types of task (and when the controls did not, ie. during slow displacements).
2. A second widely held belief, that mirror overflow more often accompanies left hand movement than right hand movement was found to be true for dyslexic children but not for controls. Greater left hand overflow was observed in the dyslexic sample for 6 tasks (including three slow displacements). Among control children, greater left hand overflow was observed for only 2 of the 13 movements tested (both were rapid repetitive tasks: forearm pronation/ supination and tapping with the index finger).
3. To summarize: In this and other studies (Parlow, 1990; Parlow & Aubin, 1991), the frequency of mirror movements in normal subjects has been found to be greatly influenced by the type of movement being studied. This was not the case for dyslexic children in the present study.

What implications might these findings have for brain organization in dyslexic children? Gladstone and Best (1985) argued that dyslexia is associated with poor interhemispheric collaboration and added that continuous disruption of interhemispheric communication in this population may interfere with the development of complementary functions in left and right cerebral hemispheres. The present findings are compatible with this view. I speculate that the dyslexic children treated all the movements (even ones which normally require considerable input from the right hemisphere) as if they were left hemisphere ones. Thus:

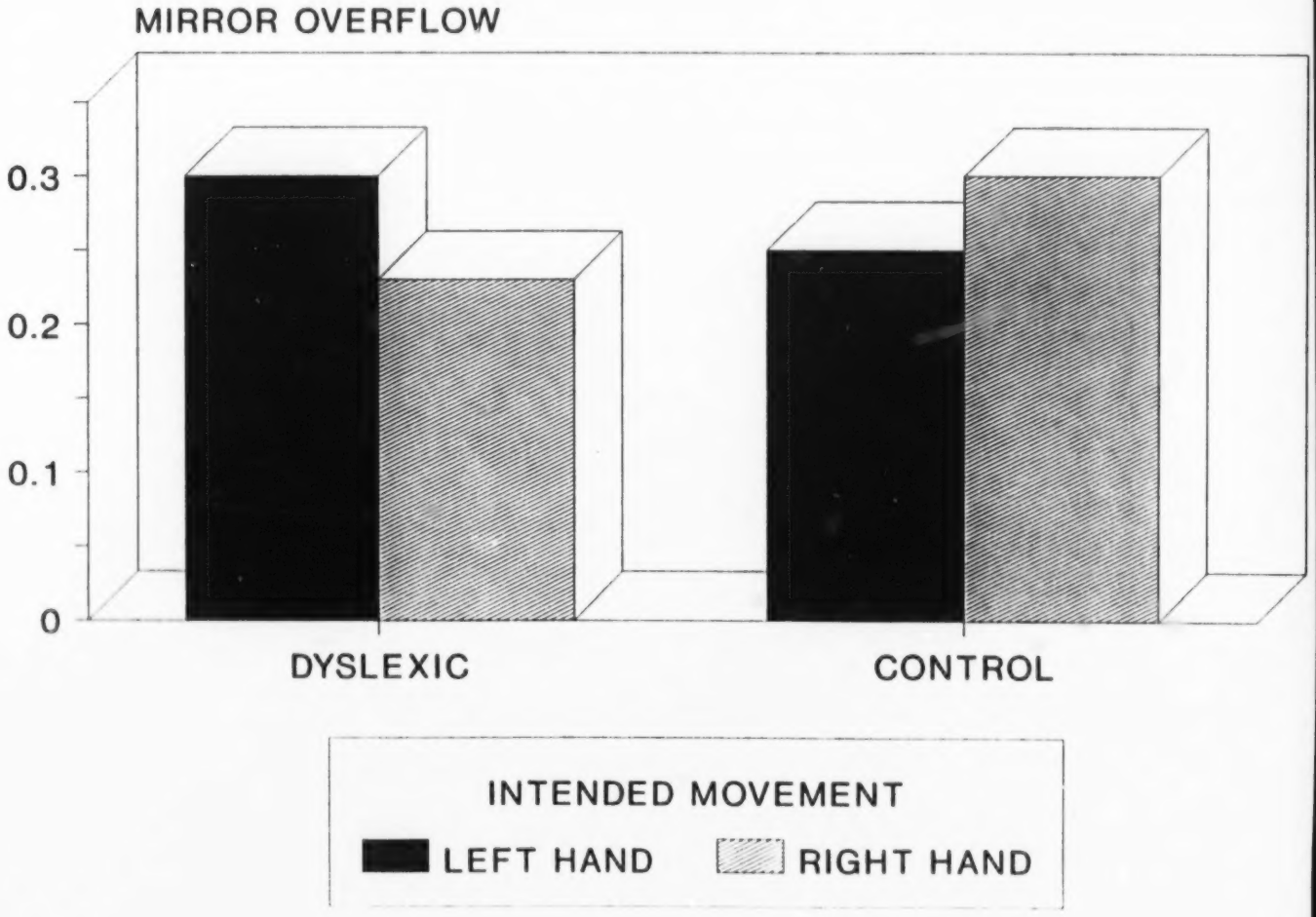
(1) dyslexic children were more likely than normal children to co-activate the left hemisphere whenever the left hand was used (and note that normal children did this only during left hemisphere tasks); and

(2) dyslexic children activated both hemispheres in circumstances where normal children did not (ie. during right hemisphere tasks).

READING ABILITY BY MOVEMENT TYPE



READING ABILITY BY HAND



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